

Amendments to the Claims

This listing of claims will replace all prior versions and listings of claims in the application:

Listing of Claims:

1. (Currently amended) A system for inspecting a specimen, comprising:

a contact image sensor, comprising a light source configured to direct light toward a surface of the specimen, a rod lens array configured to collect light from the surface of the specimen, and a first sensor array configured to detect light returned from the surface of the specimen, ~~wherein the specimen comprises a wafer having repeatable pattern features, and wherein the contact image sensor is further configured to acquire images of the repeatable pattern features and the wafer specimen~~ without contacting the waferspecimen, and wherein the contact image sensor further comprises an optical configuration for telecentric collection of the images by the rod lens array; and

a processing device coupled to the contact image sensor and configured to analyze information from the detected light or the images and to determine a characteristic of the surface of the specimen.

2. (Original) The system of claim 1, wherein the light source and the first sensor array are arranged such that the detected light comprises dark field light propagating along a dark field path.
3. (Original) The system of claim 1, wherein the light source and the first sensor array are arranged such that the detected light comprises bright field light propagating along a bright field path.
4. (Original) The system of claim 1, wherein the contact image sensor further comprises at least one additional sensor array arranged substantially parallel to the first sensor array, wherein the light source and the first sensor array are arranged such that the detected light comprises dark field light propagating along a dark field path, and wherein the light source and at least the

one additional linear sensor array are arranged such that the detected light further comprises bright field light propagating along a bright field path.

5. (Original) The system of claim 1, wherein the processing device is further configured to determine a location of defects on the surface of the specimen.

6. (Original) The system of claim 1, wherein the processing device is further configured to determine a number of defects on the surface of the specimen.

7. (Original) The system of claim 1, wherein the processing device is further configured to determine a type of defects on the surface of the specimen.

8. (Original) The system of claim 1, wherein the processing device is further configured to determine a location, a number, and a type of defects on the surface of the specimen.

9. (Original) The system of claim 1, wherein the defects comprise macro defects having a lateral dimension of greater than approximately 10 μm .

10. (Original) The system of claim 1, wherein the surface of the specimen comprises a front side of the specimen.

11. (Original) The system of claim 1, wherein the surface of the specimen comprises a back side of the specimen.

12. (Canceled)

13. (Original) The system of claim 1, wherein the contact image sensor further comprises a fiber optic bundle and a fiber optic line source, wherein the fiber optic bundle is coupled to the light source, and wherein the fiber optic line source is coupled to the fiber optic bundle.

14. (Previously presented) The system of claim 1, wherein the contact image sensor further comprises a light pipe, and wherein the light source is coupled to the light pipe.

15. (Original) The system of claim 1, wherein the light source comprises a linear array of high intensity laser diodes.

16. (Original) The system of claim 1, wherein the light source comprises a linear array of light emitting diodes.

17. (Original) The system of claim 1, wherein the contact image sensor has a height of less than approximately 30 mm.

18. (Original) The system of claim 1, wherein the contact image sensor has a height of approximately 10 mm.

19. (Currently amended) The system of claim 1, ~~further comprising a rod lens array configured to collect light from the specimen,~~ wherein each rod lens of the rod lens array is coupled to one sensor of the first sensor array.

20. (Currently amended) The system of claim 1, ~~further comprising a rod lens array configured to collect light from the specimen,~~ wherein the rod lens array is disposed within the contact image sensor such that the rod lens array is spaced above the surface of the specimen by less than approximately 10 mm.

21. (Currently amended) The system of claim 1, ~~further comprising a rod lens array configured to collect light from the specimen,~~ wherein the rod lens array is disposed within the contact image sensor such that the rod lens array is spaced above the surface of the specimen by less than approximately 3 mm.

22. (Currently amended) The system of claim 1, ~~further comprising a rod lens array configured to collect light from the specimen,~~ wherein each rod lens of the rod lens array is further configured to collect the light returned from the surface at substantially the same collection angle.

23. (Currently amended) The system of claim 1, ~~further comprising a rod lens array configured to collect light from the specimen,~~ wherein each rod lens of the rod lens array comprises ~~has a~~ numerical aperture of approximately 0.2 to approximately 0.7.

24. (Canceled)

25. (Original) The system of claim 1, wherein the first sensor array comprises a plurality of linearly aligned sensors, and wherein a pitch of the plurality of linearly aligned sensors comprises approximately 25 μm .

26. (Original) The system of claim 1, wherein the first sensor array comprises a plurality of linearly aligned sensors, and wherein a pitch of the plurality of linearly aligned sensors is configured to produce a resolution of greater than approximately 600 dots per inch.

27. (Original) The system of claim 1, wherein the first sensor array comprises a plurality of linearly aligned sensors, and wherein a pitch of the plurality of linearly aligned sensors is configured to produce a resolution of approximately 1200 dots per inch.

28. (Original) The system of claim 1, wherein the contact image sensor further comprises a circuit substrate coupled to the first sensor array, and wherein the circuit substrate comprises circuitry configured to produce a dynamic range of greater than approximately 12 bits.

29. (Currently amended) The system of claim 1, wherein the contact image sensor ~~comprises~~ has a length of at least a diameter of the specimen, and wherein the diameter of the specimen ~~comprises~~ is greater than approximately 200 mm.

30. (Currently amended) The system of claim 1, wherein the contact image sensor ~~comprises~~ has a length of at least a diameter of the specimen, and wherein the diameter of the specimen ~~comprises~~ is approximately 300 mm.

31. (Original) The system of claim 1, wherein the processing device is further configured to calibrate the first sensor array for pixel gain variation and sensor distortion.

32. (Original) The system of claim 1, wherein the contact image sensor further comprises a closed loop bar assembly.

33. (Currently amended) The system of claim 1, wherein the system further comprises a support device configured to hold ~~a~~ the specimen, and wherein the support device is configured to impart relative motion to the specimen.

34. (Currently amended) The system of claim 1, wherein the contact image sensor is further configured to move with respect to the specimen.

35. (Original) The system of claim 1, wherein the system further comprises a plurality of contact image sensors, and wherein a first of the plurality of contact image sensors is arranged above a second of the plurality of contact image sensors.

36. (Original) The system of claim 1, wherein the system further comprises a plurality of contact image sensors, and wherein the system is further configured to inspect a plurality of specimens substantially simultaneously.

37. (Previously presented) The system of claim 1, wherein the system further comprises a plurality of contact image sensors, and wherein a first of the plurality of contact image sensors is arranged laterally adjacent to a second of the plurality of contact image sensors.

38. (Previously presented) The system of claim 1, wherein the system further comprises a plurality of contact image sensors, wherein a first of the plurality of contact image sensors is arranged laterally adjacent to a second of the plurality of contact image sensors, and wherein the plurality of contact image sensors has a lateral area equal to approximately a surface area of the specimen.

39. (Original) The system of claim 1, wherein the contact image sensor is coupled to a process tool, and wherein the process tool is configured to fabricate at least a portion of a semiconductor device.

40. (Previously presented) The system of claim 1, wherein the processing device is further coupled to a process tool, and wherein the processing device is further configured to alter at least one parameter of an instrument coupled to the process tool in response to the characteristic.

41. (Currently amended) A system configured to inspect a specimen, comprising:

a contact image sensor ~~disposed~~ spaced above a surface of the specimen such that a rod lens array is spaced above the surface of the specimen by less than approximately

10 mm, wherein the contact image sensor has a height of less than approximately 10 mm, the contact image sensor comprising:

a light source configured to direct light toward the surface of the specimen;

wherein the rod lens array is configured to collect light returned from the surface of the specimen, wherein a collection angle of each rod lens is substantially equal, and, wherein the contact image sensor further comprises an optical configuration for telecentric collection of specimen images by the rod lens array, ~~wherein the specimen comprises a wafer having repeatable pattern features, and wherein the specimen images comprise images of the repeatable pattern features; and~~

a first sensor array configured to detect light collected by the rod lens array, wherein each rod lens is coupled to one sensor of the first sensor array; and

a processing device coupled to the contact image sensor and configured to determine a presence of defects on the surface of the specimen using the specimen images.

42.-80. (Canceled)

81. (Currently amended) A method for inspecting a specimen, comprising:

directing light from a light source toward a surface of the specimen, ~~wherein the specimen comprises a wafer having repeatable pattern features;~~

collecting light returned from the surface of the specimen using a rod lens array, wherein each rod lens of the rod lens array ~~comprises~~ has a diameter of approximately 10 microns, and wherein a collection angle of each rod lens is substantially equal;

detecting the collected light using a first sensor array, wherein the light source, the rod lens array, and the first sensor array are arranged in a contact image sensor, wherein each rod lens is coupled to one sensor of the first sensor array, wherein the contact image sensor is disposed spaced above ~~a~~ the surface of the specimen such that the rod

lens array is spaced above the surface of the specimen by less than approximately 10 mm, wherein the contact image sensor comprises has a height of approximately 10 mm, and wherein the contact image sensor comprises an optical configuration for telecentric collection of specimen images by the rod lens array, ~~and wherein the specimen images comprise images of the repeatable pattern features; and~~

determining a presence of defects on the surface of the specimen from the specimen images.

82. (Currently amended) A method for inspecting a specimen between two process steps, comprising:

transporting the specimen from a first process chamber to a second process chamber;

directing light from a light source toward a surface of the specimen during said transporting;

collecting light returned from the surface of the specimen using a rod lens array during said transporting;

detecting the collected light using a first sensor array during said transporting, wherein the light source, the rod lens array, and the first sensor array are arranged in a contact image sensor, wherein the contact image sensor is spaced above the surface of the specimen such that the rod lens array is spaced above the surface of the specimen by less than about 10 mm, ~~wherein the specimen comprises a wafer having repeatable pattern features, and wherein the collected light comprises specimen images that comprise images of the repeatable pattern features, and wherein the contact image sensor comprises an optical configuration for telecentric collection of the specimen images by the rod lens array; and~~

determining a presence of defects on the surface of the specimen from the specimen images.

83. (Original) The method of claim 82, wherein the first process chamber and the second process chamber are coupled to a semiconductor fabrication process tool.

84. (Original) The method of claim 82, wherein the first process chamber and the second process chamber are coupled to a semiconductor fabrication process tool, and wherein the semiconductor fabrication process tool comprises a chemical-mechanical polishing tool, an etch tool, a deposition tool, a lithography tool, or an ion implantation tool.

85. (Original) The method of claim 82, wherein the first process chamber is coupled to a first semiconductor fabrication process tool, and wherein the second process chamber is coupled to a second semiconductor fabrication process tool.

86. (Currently amended) A semiconductor device fabricated by a method, the method comprising:

forming a portion of the semiconductor device upon a wafer;

directing light from a light source toward a surface of the portion of the semiconductor device;

collecting light returned from the surface of the portion of the semiconductor device using a rod lens array;

detecting the collected light using a first sensor array, wherein the light source, the rod lens array, and the first sensor array are arranged in a contact image sensor, wherein the contact image sensor is spaced above the surface of the portion of the semiconductor device such that the rod lens array is spaced above the surface by less than about 10 mm, wherein the wafer comprises repeatable pattern features, and wherein the collected light comprises wafer images that comprise images of the repeatable pattern features, and wherein the contact image sensor comprises an optical configuration for telecentric collection of images of the wafer by the rod lens array; and

determining a presence of defects on the surface of the portion of the semiconductor device from the ~~wafer images~~.

87. (Currently amended) A method for fabricating a semiconductor device, comprising:

forming a portion of the semiconductor device upon a wafer;

directing light from a light source toward a surface of the portion of the semiconductor device;

collecting light returned from the surface of the portion of the semiconductor device using a rod lens array;

detecting the collected light using a first sensor array, wherein the light source, the rod lens array, and the first sensor array are arranged in a contact image sensor, wherein the contact image sensor is spaced above the surface of the portion of the semiconductor device such that the rod lens array is spaced above the surface by less than about 10 mm, wherein the wafer comprises repeatable pattern features, and wherein the collected light comprises wafer images that comprise images of the repeatable pattern features, and wherein the contact image sensor comprises an optical configuration for telecentric collection of images of the wafer by the rod lens array; and

determining a presence of defects on the surface of the portion of the semiconductor device from the wafer-images.

88. (Currently amended) A computer-implemented method for controlling a system configured to inspect a specimen, wherein the system comprises a contact image sensor, the method comprising:

controlling the contact image sensor, wherein the contact image sensor comprises a light source, a rod lens array, and a first sensor array, comprising:

controlling the light source to direct light toward a surface of the specimen;

collecting light returned from the surface of the specimen using the rod lens array, wherein the contact image sensor is spaced above the surface of the specimen such that the rod lens array is spaced above the surface of the specimen by less

~~than about 10 mm, wherein the specimen comprises a wafer having repeatable pattern features, and wherein the collected light comprises specimen images that comprise images of the repeatable pattern features, and wherein the contact image sensor further comprises an optical configuration for telecentric collection of the specimen images by the rod lens array; and~~

controlling the first sensor array to detect the collected light; and

processing the ~~detected light~~specimen images to determine a presence of defects on the surface of the specimen.

89. (Original) The method of claim 88, wherein the contact image sensor further comprises a fiber optic bundle and a fiber optic line source, wherein the fiber optic bundle is coupled to the light source, and wherein the fiber optic line source is coupled to the fiber optic bundle.

90. (Original) The method of claim 88, wherein the contact image sensor further comprises a light pipe, and wherein the light source is coupled to the light pipe.

91. (Currently amended) The method of claim 88, wherein the contact image sensor further ~~comprises~~has a height of less than approximately 30 mm.

92. (Currently amended) The method of claim 88, wherein the contact image sensor further ~~comprises~~has a height of approximately 10 mm.

93. (Currently amended) The method of claim 88, ~~wherein said light is collected using a rod lens array, and wherein each rod lens of the rod lens array is coupled to one sensor of the first sensor array.~~

94. (Canceled)

95. (Currently amended) The method of claim 88, ~~wherein said light is collected using a rod lens array, and wherein the rod lens array is disposed within the contact image sensor such that the rod lens array is spaced above the surface of the specimen by less than approximately 3 mm.~~

96. (Currently amended) The method of claim 88, ~~wherein said light is collected using a rod lens array, and~~ wherein each rod lens of the rod lens array is configured to collect light at substantially the same collection angle.

97. (Currently amended) The method of claim 88, ~~wherein said light is collected using a rod lens array, and~~ wherein each rod lens of the rod lens array ~~comprises~~ has a numerical aperture of approximately 0.2 to approximately 0.7.

98. (Canceled)

99. (Original) The method of claim 88, wherein the first sensor array comprises a plurality of linearly aligned sensors, and wherein a pitch of the plurality of linearly aligned sensors comprises approximately 25 μm .

100. (Original) The method of claim 88, wherein the first sensor array comprises a plurality of linearly aligned sensors, and wherein a pitch of the plurality of linearly aligned sensors produces a resolution of greater than approximately 600 dots per inch.

101. (Original) The method of claim 88, wherein the contact image sensor further comprises a circuit substrate coupled to the first sensor array, and wherein the circuit substrate comprises circuitry configured to produce a dynamic range of greater than approximately 12 bits.

102. (Currently amended) The method of claim 88, wherein the contact image sensor ~~further comprises~~ has a length of at least a diameter of the specimen, and wherein the diameter of the specimen ~~comprises~~ is greater than approximately 200 mm.

103. (Original) The method of claim 88, further comprising controlling the contact image sensor to calibrate the first sensor array for pixel gain variation and sensor distortion.

104. (Previously presented) The method of claim 88, wherein the contact image sensor further comprises a closed loop bar assembly.

105. (Original) The method of claim 88, further comprising controlling a support device to move the specimen with respect to the contact image sensor.

106. (Original) The method of claim 88, further comprising controlling the contact image sensor to move the contact image sensor with respect to the specimen.

107. (Original) The method of claim 88, wherein the system further comprises a plurality of contact image sensors, the method further comprising controlling the plurality of contact image sensors.

108. (Original) The method of claim 88, wherein the contact image sensor is coupled to a process tool, the method further comprising altering at least one parameter of an instrument coupled to the process tool using the determined presence of defects on the surface of the specimen.

109. (Currently amended) An apparatus for inspecting a substrate, comprising:

- a. a light source for illuminating at least a portion of said substrate;
- b. optics for collecting light from said illuminated portion, ~~wherein the substrate comprises a wafer having repeatable pattern features, and wherein the collected light comprises substrate images that comprise images of the repeatable pattern features;~~
- c. a plurality of sensors for sensing said collected light; and
- d. a processor for determining the presence of a defect or process variation on said substrate, wherein said optics and said sensors and at least a portion of said light source are contained in an integrated package proximate to and spaced above said substrate, and wherein said optics and said sensors comprise an optical configuration for telecentric collection of the substrate images.

110. (Previously presented) The apparatus of claim 109, wherein the presence of said defect is determined by comparing said portion of said substrate with another, nominally identical portion of said substrate.

111. (Previously presented) The apparatus of claim 110, wherein said substrate further comprises a plurality of semiconductor dies, and said portion of said substrate is contained on one of said dies and said nominally identical portion is contained on another of said dies.

112. (Previously presented) The apparatus of claim 110, wherein said substrate further comprises an array of substantially identical elements, and said portion of said substrate is contained in a first region of said array and said nominally identical portion is contained in a second region of said array.

113. (Previously presented) The apparatus of claim 112, wherein said first and second regions are contained within a single semiconductor die.

114. (Currently amended) A method of inspecting a substrate, comprising inspecting said substrate with a contact image sensor to detect defects on said substrate, ~~wherein the substrate comprises a wafer having repeatable pattern features,~~ wherein said inspecting comprises acquiring substrate images with the contact image sensor without contacting the substrate, and ~~wherein the substrate images comprise images of the repeatable pattern features, and wherein the contact image sensor comprises an optical configuration for telecentric collection of the substrate images.~~

115. (Canceled)

116. (Currently amended) The method of claim 114, wherein both a front and a back side of said ~~wafer~~ substrate are inspected.

117. (Previously presented) The method of claim 114, wherein said inspecting comprises macro defect inspection.

118. (Currently amended) A method of inspecting a substrate, comprising:

a. illuminating at least a portion of said substrate;

b. collecting light from said portion, and transmitting said collected light to a plurality of sensors at approximately a 1:1 magnification, ~~wherein the substrate comprises a~~

~~wafer having repeatable pattern features, and wherein the collected light comprises substrate images that comprise images of the repeatable pattern features, and wherein said illuminating and said collecting is performed by a contact image sensor spaced above the substrate and comprising an optical configuration for telecentric collection of the substrate images; and~~

- c. processing data from said plurality of sensors to determine the existence of defects or process variations within said portion.

119. (Original) The method of claim 118, wherein said data is processed to detect macro defects within said portion.